INSTRUCTION MANUAL

MODEL 123A

VCF WAVEFORM GENERATOR

SN 18000 AND UP

EXACT electronics, inc.®
Box 347 Tillamook OR 97141
Telephone 503-842-8441
TWX 510-590-0918

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REV 1/79

IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper setup.
2. Check fuse and power supply voltages.
3. Call your Exact representative or factory. Instruments returned to the factory will be accepted only if they are sent freight prepaid, unless Exact or factory representative has authorized otherwise.

CLAIM FOR DAMAGED SHIPMENT

The instrument should be inspected as soon as received. If damage has occurred, a claim should be made with the carrier. The claim agent should receive a complete report of damage and a copy sent to Exact. After receiving this report, Exact will advise you of the dispostion of the instrument and arrange for its repair or replacement.

WARRANTY

Exact warrants its instruments to be free from defects in material and workmanship under normal use for a period of twelve months from the original date of shipment. Exact's obligation is limited to repair or replacement.

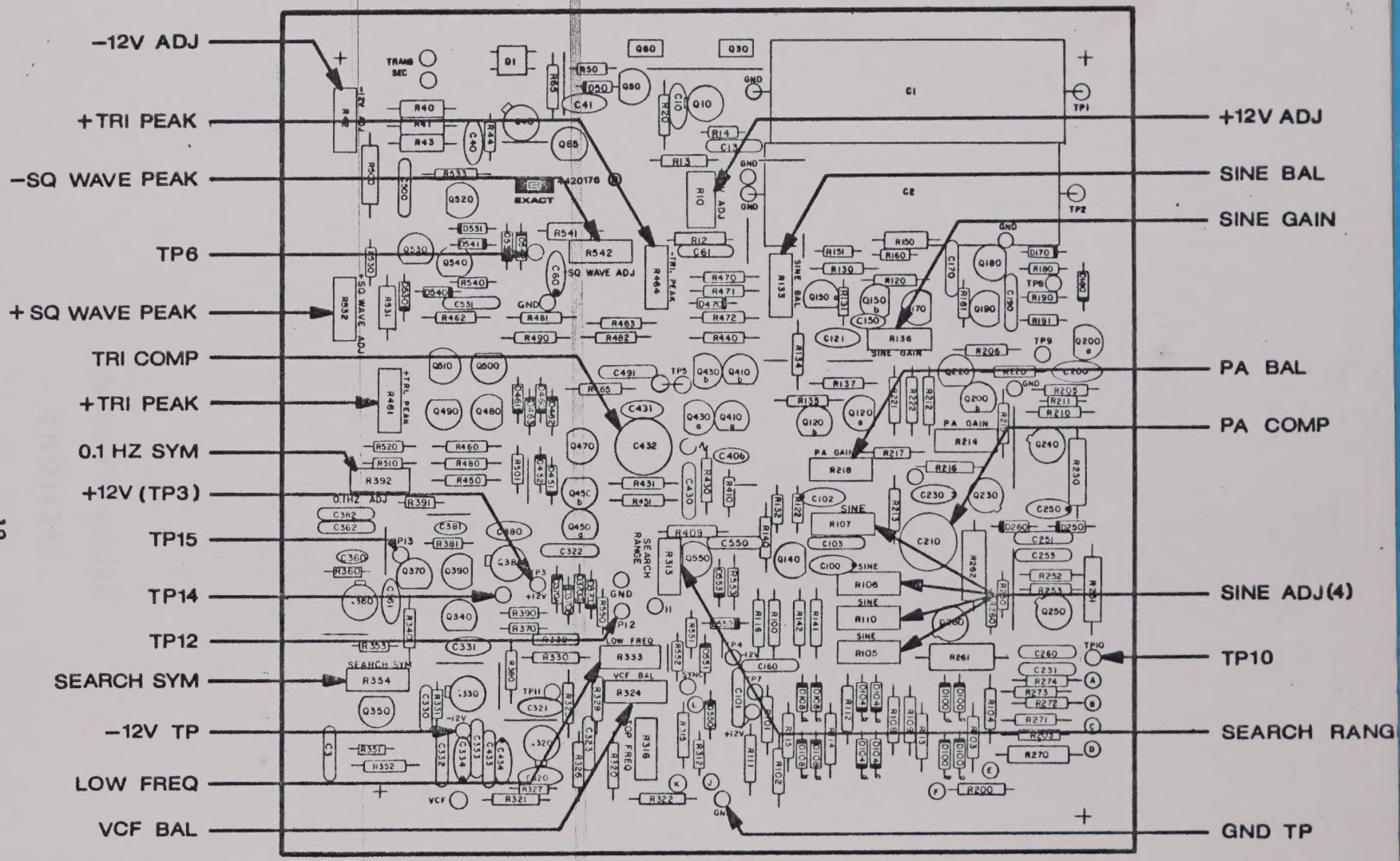
All repairs and replacements made under this warranty are f.o.b. Exact's factory or designated service depot unless otherwise authorized by Exact. This warranty is made on condition that prompt notice of defect is given to Exact, in writing, within the warranty period and that Exact shall have the sole right to determine whether in fact a defect exists.

This warranty does not apply to any instrument which has been repaired or altered by other than Exact's own service representative so as, in Exact's judgment, to adversely affect it, nor which has been subject to misuse, negligence or accident or which has been operated contrary to sound practice or operating instructions.

SECTION 1

CONTENTS

SECTION 2	SPECIFICATIONS
SECTION 3	OPERATION
SECTION 4	CIRCUIT DESCRIPTION
SECTION 5	CALIBRATION
SECTION 6	PARTS LIST
SECTION 7	SCHEMATICS
SECTION 8	ADDENDA



ADJUSTMENT LOCATION DETAIL

MODEL 123A FIGURE 5.3.2

SECTION 2

SPECIFICATIONS

WAVEFORMS

Sine, square, triangle and sync.

DYNAMIC FREQUENCY RANGE

0.1 Hz to 5 MHz.
(20 Hz to 20 KHz in the 20K range).

SYNC OUTPUT

Square wave approximately 2V P-P open circuit. 100-ohm output impedance.

FREQUENCY MULTIPLIER (Kelvin-Varley Divider) ACCURACY

±2% of frequency range (typically ±2% of setting)

MAIN OUTPUT

50 ohms output impedance
All waveforms > 20V P-P open circuit,
> 10V P-P into 50 ohms.
A full 60dB of attenuation is provided with 20dB steps.

VCF (Voltage-Controlled Frequency)

Approximately 5V input for 1000:1 (three decades) frequency ratio.
VCF input is usable to 1 MHz input frequency.

SINE WAVE DISTORTION

< 0.5% 0.1 Hz to 100 KHz (typically 0.2%). No harmonics < 30dB down
100 KHz to 5 MHz (typically 38 to 42dB down).

SINE FREQUENCY RESPONSE

0.1dB to 100 KHz; 0.5dB to 5 MHz.

SQUARE WAVEFORM

Rise and fall < 60 nanosec. Overshoot and ringing < 5%.

TRIANGLE LINEARITY

99% to 100 KHz, 95% to 5 MHz.

DC OFFSET

Variable ±5V into 50 ohms, ±10V, open circuit. Note DC offset plus signal cannot exceed maximum voltage output or clipping will occur.

FREQUENCY STABILITY

0.04% of setting for 10 min., 0.2% of setting for 24 hours.

AMPLITUDE STABILITY

0.05% of max P-P amplitude for 10 min., 0.2% of max P-P amplitude for 24 hrs.

Note; All stabilities are for constant line voltage and temperature and do not apply in the Search mode of operation.

SYMMETRY (time)

99%

POWER REQUIREMENTS

Input Voltage - 115 VAC ± 10% or 220 VAC ± 10%.
Frequency - 50 to 400 Hz, Power Consumption 10W.

PHYSICAL CHARACTERISTICS

7-3/8"W x 2-7/8"H x 8-1/2"D.
Weight 4 lbs net, 6 lbs shipping.
Top and bottom covers easily removable, exposing all calibration and circuit board areas.

NOTE: (unless otherwise stated).

Specifications apply from 10% to full amplitude with output terminated into 50 ohms and do not apply in the Search Mode. Specifications are valid at 25°C ± 5°C and with 105-125 VAC or 200-250 VAC line voltage applied. For operation at 0-50°C, derate all specifications by a factor of 2.5. Prices and specifications are subject to change without notice.

SECTION 3

FRONT PANEL FAMILIARITY

OPERATING INSTRUCTIONS

(Figure 3.1.1 deleted)

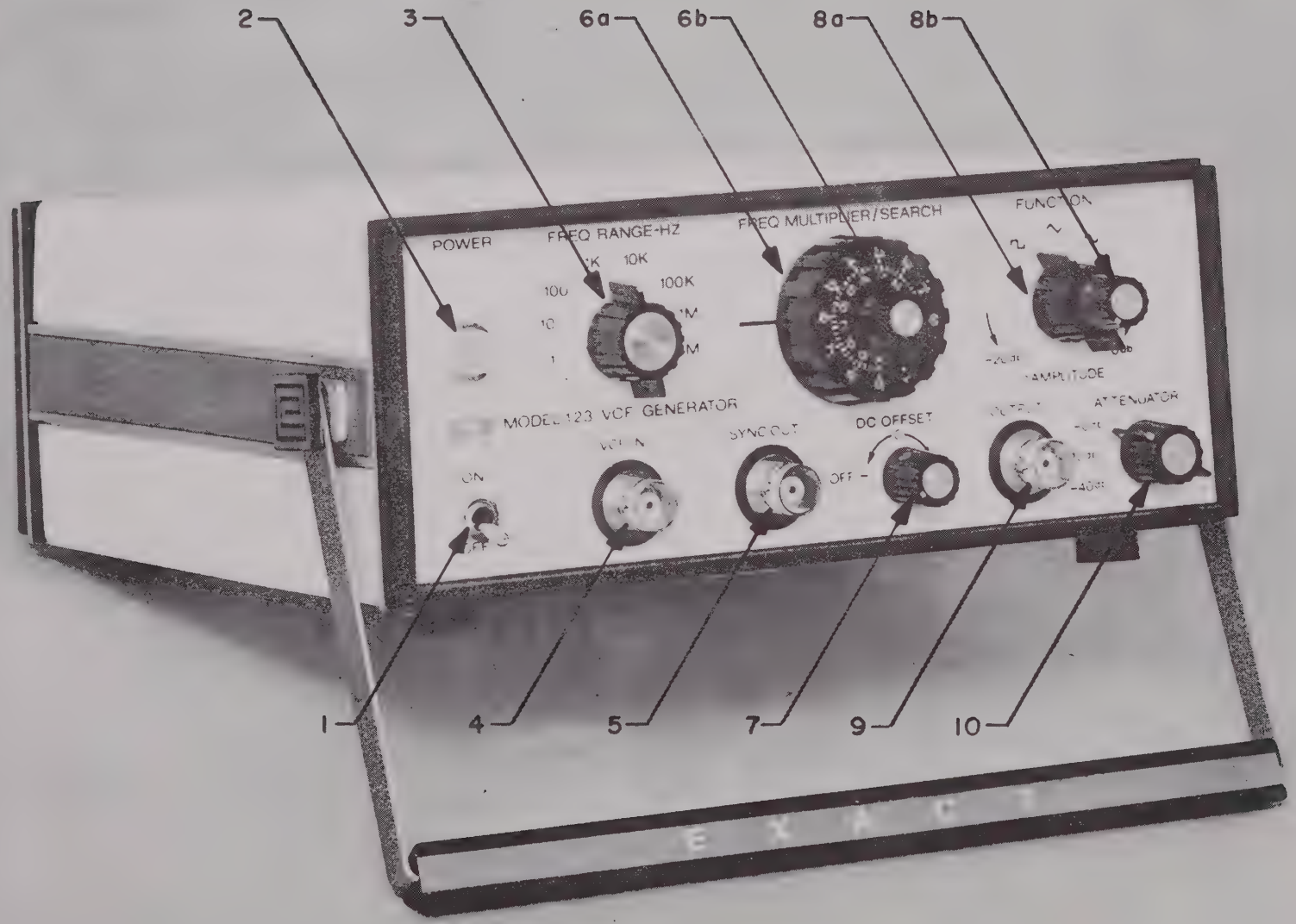


FIGURE 3.1.2 FRONT PANEL MODEL 123

3.1.1 FRONT PANEL FAMILIARITY, MODEL 123

1. Power On/Off switch - turns on input power to instrument.

2. Pilot lamp - indicates input power On.

3. Range switch - selects frequency range of output waveform.

4. VCF input - input connector for external frequency control.

5. Sync Out connector - provides trigger output voltage in phase with the square waveform.

6. Multiplier dial - Kelvin-Varley type multiplier provides vernier frequency control of output waveform.

7. D.C. Offset control - selects D.C. offset amplitude (also has Off position).

8a. Function switch - selects square, triangle or sine.

8b. Amplitude control - vernier amplitude adjust of output waveform.

9. Output connector - provides 50-ohm output impedance of selected waveform.

10. Attenuator - selects 20 dB amplitude steps for clean output waveforms at low amplitude.

NOTE: This instrument is equipped with a floating circuit ground which may be tied to the chassis ground or floated to some other source by the connection of the grounding strap on the rear panel.

3.2.1 FIRST TIME OPERATION

NOTE: Before applying power to the instrument, the input power connection should be checked to be certain the instrument has been wired for the correct power supply voltage. Refer to Power Transformer connection on the power supply schematic diagram (fig. 7.2.2). The correct fuse should be in the rear panel fuse holder as specified in the chart on the instrument rear panel.

1. Plug instrument into source of 110V or 220V 50 to 400 cycle A.C. power and turn on power switch. Set controls as follows:

RANGE switch	1KHz
MULTIPLIER dial	1.0
FUNCTION switch	SINE
AMPLITUDE vernier	MAX CW
D.C. OFFSET	OFF
OUTPUT ATTEN	0dB

2. Connect generator output through 50-ohm coaxial cable into 50-ohm coaxial load and the vertical input of a suitable oscilloscope. The instrument should be providing a 1KHz sine waveform at approximately 10V P-P amplitude under these conditions.

3. Switch Function selector through its various output waveforms and observe on the oscilloscope.

4. Switch the D.C. Offset switch to Variable and observe that a D.C. voltage can be superimposed upon the output voltage by the adjustment of the D.C. offset control potentiometer.

5. The output amplitude can be adjusted over its 60 dB of dynamic range by the combination of output amplitude vernier and attenuator switch.

6. The frequency of the instrument may be selected by the combination of the proper range switch setting and the Kelvin-Varley multiplier dial settings.

NOTE: It is recommended that the rear panel chassis ground and circuit ground connections be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

SECTION 4

CIRCUIT DESCRIPTION

4.1.1 INTRODUCTION

The simple block diagram in figure 1 shows the closed loop operation of the function generator. The diode gate allows only one current source to charge the integrating capacitor at a time. Assume that the positive current source is charging the capacitor; this results in a linear rise in voltage, the slope of which is determined by the magnitude of current and the size of the capacitor. When the voltage reaches the trip point of the level detector, the bi-stable switch changes states and the diode bridge switches the integrating capacitor to the negative current source and the voltage level starts moving negative. When the voltage reaches the opposite trip level of the level detector, the bi-stable switch changes states and the process reverses again. The triangle buffer offers a high input impedance so the integrating capacitor is not loaded causing curvature and a low output impedance to drive the level detector and any other required circuitry.

The output of the buffer is a triangle and the level detector output is a square wave. The triangle is applied to a convertor which changes it to a sine wave and the output is amplified back to the level of the triangle. These three outputs can then be applied to a power amplifier.

The frequency can be changed by changing the charging current or the integrating capacitor. Since the triangle amplitude is fixed by the firing points of the level detector, the amplitude of the triangle (and therefore the sine) is constant with changes in frequency. The magnitude of current integrating is controlled by the VCF input voltage and the multiplier dial to control the frequency within the range and the range is controlled by selecting the integrating capacitors.

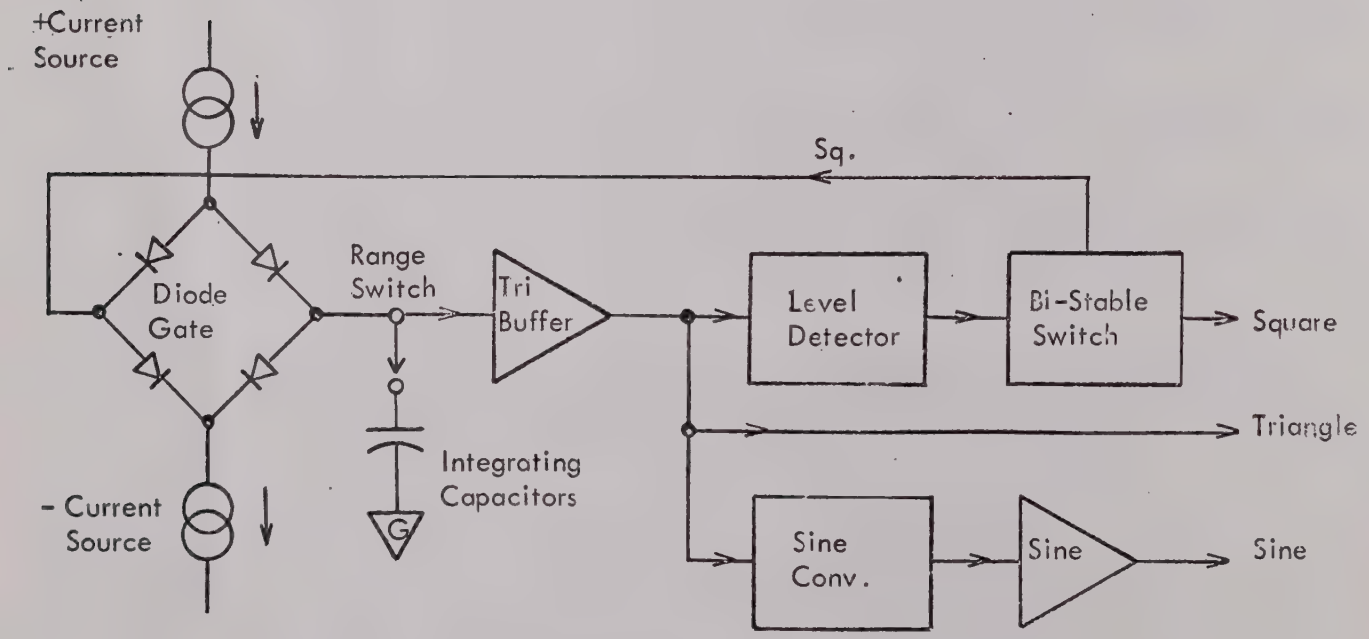


Figure 1

4.1.2 CURRENT SOURCES AND INTEGRATOR

Q360, Q370 and associated circuitry make up the positive voltage-controlled current source. Q380, Q390 and their circuitry serve as the negative current source. D370 makes up the diode switching bridge which gates the proper current source into the selected integrating capacitor. S400, the frequency range switch, selects the integrating capacitor and resistors in the current sources.

The preceding circuitry sets the currents in R352 A and B which are in the positive inputs of the current source amplifiers. The selected current source resistors, for example R403 A and B, are in the negative input of the current source amplifiers. Any difference in the currents in the positive and negative inputs is seens as an error signal by the amplifiers and is correct. Field effect transistors Q370 and Q390 isolate the amplifier circuitry from the integrator.

Q330 and Q340 serve as a voltage to current convertor. R340 serves as a current sensing resistor. Any difference between the voltage applied at the positive input of the amplifier (pin 3) and the voltage developed across R340 by the current supplied to the current sources results in an error signal which is corrected by the amplifier, Q330.

Q350B provides a virtual ground for current sense resistor R340, while delivering current to R352A in the positive current source. The emitter of Q350A is connected to ground. Since the transistors are matched, the emitter of Q350B is also at ground. The base emitter voltages of the two transistors track with temperature and the collector of Q350B delivers current to the positive current source. The voltage from S300 is summed with any D.C. voltage or A.C. modulating voltage applied at the VCF input connector and the frequency is determined by the algebraic sum of the two. R316 sets the voltage applied to the frequency multiplier and therefore the maximum frequency within a selected range. R324 compensates for source current and offset voltage in the summing amplifier so that the frequency remains correct when a low impedance source is connected to the VCF input connector. R333 compensates the offset voltage in the voltage to current convertor and therefore insures that the frequency is correct when small voltages (low frequency end of range) are applied. R354 is used to adjust the balance at very low input voltages and thus sets the time symmetry at the bottom end of the Search mode.

4.1.3 TRIANGLE BUFFER AMPLIFIER

Q410 and Q430 serve as a unity gain, high input impedance buffer amplifier for the triangle. The bi-polar transistor Q430 base emitter drops offset and termperature compensate the FET gate voltages resulting in a zero offset, temperature compensated amplifier.

4.1.4 LEVEL DETECTOR

Q450 A and B with current source transistor Q470 serve as a simple voltage comparator. The reference level at the base of Q4506 is determined by one of the resistive current sources switched in by diode gate D460 through D463. D451 and D452 limit the collector swing for increased speed. The collectors of Q450 A and B drive a non-saturating current mode switch made up of Q480 through Q510. Q520 is a transistor connected as a Zener diode to supply approximately -7V for the collectors of Q500, Q510, and Q540. The square wave output at the emitter of Q500 drives the diode bridge in the integrator, the diode bridge in the level detector and the sync output circuit, Q550. C432 is a lead capacitor used to compensate for any delays in the loop and keep the triangle from peaking on the highest frequency range.

4.1.5 SQUARE BUFFER

Q530 and Q540 drive a diode gating bridge, D531, D532, D541, and D542. The diode bridge switches in one of the two resistive current sources on opposite half cycles to develop the square wave for the power amplifier when the square output is selected. R532 and R542 are adjusted to set the amplitude of the square wave peaks.

4.1.6 SYNC OUTPUT

The sync output, Q550, is simply an emitter follower with diode clamping at the output.

4.1.7 SINE CONVERTOR AND AMPLIFIER

Diodes D100, D104 and D108 form three diode bridges similar to the bridge used in the integrator. In this case, however, the diode bridges are driven by the triangle and are switched at several different points on the triangle determined by the current source resistors in series with the bridges, R103 through R112. The triangle is attenuated and as each bridge reaches its switch point the slope is changed. This occurs on both half cycles and the result is a low level sine wave across R116.

The sine amplifier is made up of two differential stages, Q120 and Q150 driving an isolation emitter follower, Q170. Diodes D170 and D180 prevent cross-over distortion in the push-pull emitter follower, Q180 and Q190. The feedback network of R135 through R137 sets the gain so that the sine wave is equal in amplitude to the triangle. Q140 serves as a current source for the input differential pair. S200, the function switch, delivers the triangle to the sine convertor in only the sine position and selects the output of the sine amplifier to be delivered to the power amplifier.

4.1.8 POWER AMPLIFIER (MAIN OUTPUT)

S200 selects the desired function and delivers it to amplitude control R202. R202 gives a little more than 20dB of attenuation in the counterclockwise position. The power

4.1.8 POWER AMPLIFIER (continued)

amplifier is made up of two differential stages driving a push-pull emitter follower. Q220 serves as a current source for differential pair Q200 A and B. D230 and D240 bias the push-pull emitter follower Q250 and Q260 to prevent cross-over distortion. The feedback network of R213 through R215 adjusts the gain of the amplifier and C210 is adjusted for optimum transient response. R218 is the internal D. C. balance (offset) adjustment. R219 is the front panel ±5V D. C. offset control and S219 is the D.C. offset "off" switch in the CCW rotation. R270 through R274 make up two 20db step attenuators that can be selected by the front panel attenuator switch, S200.

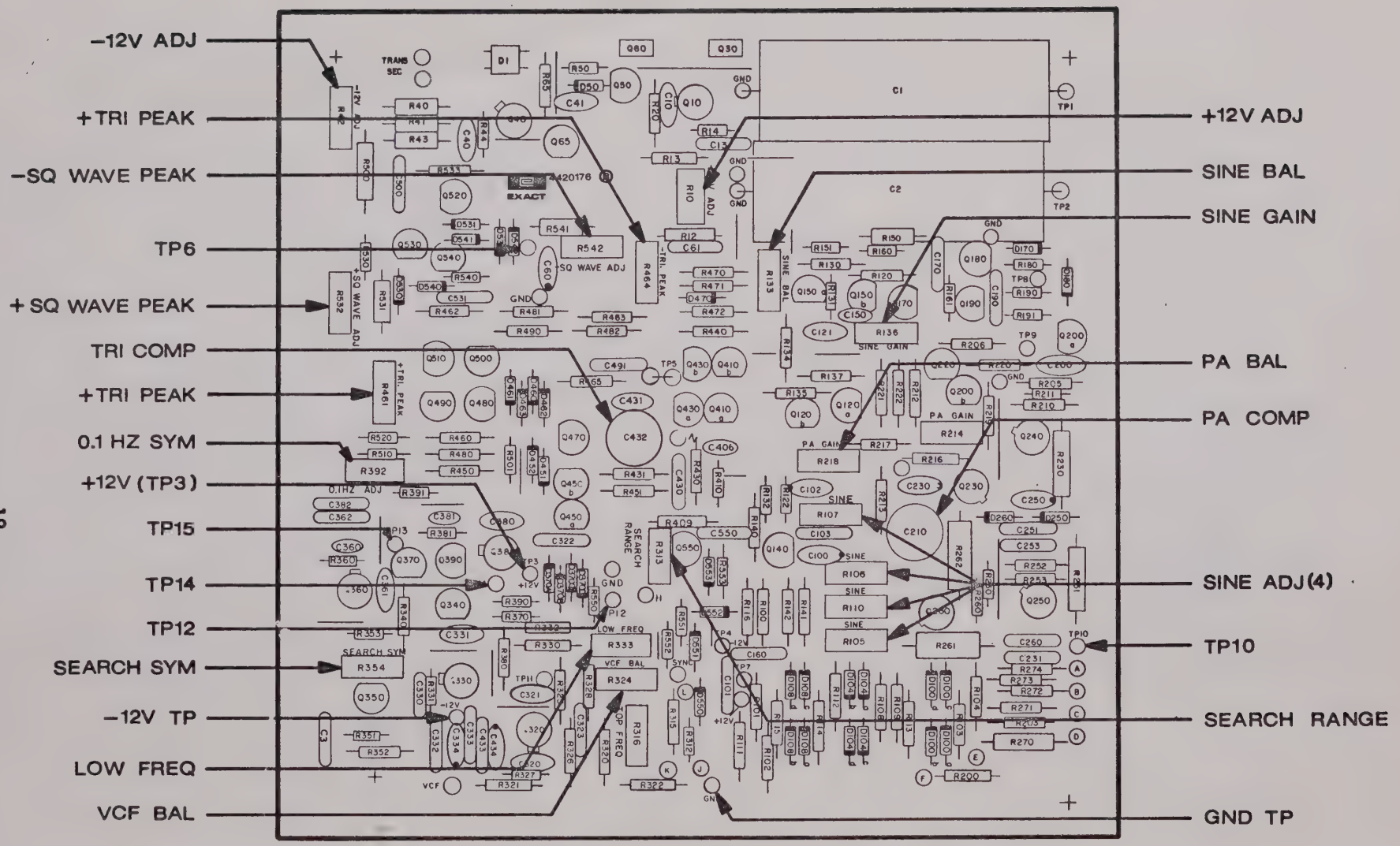
4.1.9 POWER SUPPLIES

A.C. power is applied through F1 and S1, the power switch, to transformer T1. The primaries of T1 are connected in paralled for 117V operation and in series for 220V operation. Full wave rectification is supplied by diode bridge D1 and filtering by C1 and C2, giving unregulated D.C. outputs of ±22V D.C. These voltages are used in the power amplifier, the positive and negative current source in the main generator, and are applied to the positive and negative 12V regulators Q10 and Q40. Divider R10, R12, and R13 adjust the voltage to be compared to reference voltage developed in Q10. R10 is adjusted for no error to integrated power supply Q10 when the regulated output is ±12V. Q20 is the series pass transistor. Q40 serves as an amplifier to compare the -12V supply to the ±12V supply and to amplify any error to maintian the minus supply equal to the positive supply but of opposite polarity. The output of Q40 is applied to Q50 and Q60 to provide additional current gain. Q65 provides short circuit protection for the negative supply.

SECTION 5

CALIBRATION

(Figure 5.3.1 deleted)



ADJUSTMENT LOCATION DETAIL

MODEL 123A FIGURE 5.3.2

5.1.0 EQUIPMENT REQUIRED

The following test equipment or suitable equivalents of known accuracy are required for complete calibration.

Oscilloscope, D.C. to 50 MHz bandwidth, Tektronix 545 with IAI and W or IA5 plug-ins, or equivalent.
Distortion analyzer, Hewlett-Packard 333A or equivalent.
Adjustable line voltage transformer, superior powerstat or equivalent.
Constant voltage power supply accurate to 1 mV.
Frequency and time interval counter, Fairchild or equivalent.
Differential or digital voltmeter, Fairchild Model 7000 or equivalent.

5.2.0 INITIAL CONTROL SETTINGS

RANGE	1 KHz
MULTIPLIER	X1.0
FUNCTION	TRIANGLE
OFFSET adj.	CCW (off)
OUTPUT ATTEN	0dB
OUTPUT VERNIER	FULL CW
POWER switch	ON

5.3.0 CALIBRATION

1. Connect voltmeter from TP3 to ground. Adjust +12 VOLT ADJ for +12.00V ± 10mV.

2. Connect voltmeter from TP4 to ground. Adjust -12 VOLT ADJ for -12.00V ± 10mV.

3. Connect terminated cable from output connector to distortion analyzer and adjust 4 SINE adjustments and ± TRI PEAKS for minimum harmonic distortion.

4. Set Range to 100K, Multiplier to S.0. Connect 50-ohm cable terminated in 50 ohms from output connector to input of counter. Alternately short and open the center connector of the VCF input to ground. Adjust VCF bal for no change in frequency when the VCF input is shorted.

5. RESET RANGE to 1K and Multiplier to 1.00, adjust TOP FREQ for 1.00 KHz ± 1%.

6. Change Multiplier to 0.1. Adjust LOW FREQ ADJ for 100.0 Hz ± 1%. Repeat steps 5 and 6 if necessary. Check multiplier dial tracking.

7. Set Multiplier dial to 1.00. Connect 50 ohm cable terminated in 50 ohms from output connector to oscilloscope. Adjust P.A. BAL for symmetry about ground ± 100 mV.

8. Set Function to square. Adjust +SQ WAVE ADJ for +5V (+100 mV, -0 mV) and -SQ WAVE SYMMETRY to -5V (-100 mV, +0 mV).

5.3.0 CALIBRATION (continued)

9. Set Function to sine. Adjust SINE GAIN for 10V P-P +100 mV -0 mV sine wave. Adjust SINE BAL for symmetry about ground.

10. Set RANGE to 1 MHz. Adjust HP COMP for 1 MHz ± 2%. Set Range to 5 MHz. Adjust 5 MHz ADJ for 5 MHz ± 2%. NOTE: 5 MHz adjust is located on range switch.

11. Adjust P.A. COMP for optimum square wave with minimum overshoot and ringing; with sine frequency response $<$.5dB down at 5 MHz.

12. Check all ranges for correct frequency.

13. Set Range to 1 Hz, Multiplier to 0.1. Adjust 0.1 Hz symmetry for time symmetry ± 1%.

14. Set Multiplier to S.X, Range to 100 KHz. Set search dial max CCW S.O. adjust SEARCH RANGE ADJUST for 100 Hz ± 5%.

15. Adjust SEARCH SYMMETRY ADJUST for time symmetry ± 2%.

16. Apply +5 D.C. ± 5 mV to VCF input. Insure that frequency increases to at least 100 KHz.

17. Check output attenuator for proper attenuation.

SECTION 6

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Sprgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidaire Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J.
00616	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. Ordill Div. (Caps)	Marion, Illinois
00866	Goe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01561	Chassi-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp/Amer.	Saugerties, N.Y.
02286	Cole Mfg. Co.	Palo Alto, Calif.
02660	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Company of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03954	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04222	Mi-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co. Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola/Semicon. Prod.	Phoenix, Arizona
04732	Filtron Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04796	Sequoia Wire/Cable Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Basick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst. Co.	Penacook, N.H.
06751	U.S. Semcor Div. of Nuclear Corp/Amer.	Phoenix, Ariz.
06812	Torrington Mfg Co. West Div.	Van Nuys, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07261	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Birtcher Corp.	Los Angeles, Calif.
07700	Technical Wire Products	Springfield, N.J.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Bilon, Delbert, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elect Co., Phoenix Div.	Phoenix, Ariz.
08792	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atohm Electronics	Sun Valley, Calif.
09250	Electra Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd.	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10214	Gen. Trans. Western Corp.	Los Angeles, Calif.
10411	Trans-Tek, Inc.	Berkeley, Calif.
10397	Exact Electronics, Inc.	Hillsboro, Oreg.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel. of Calif., Inc.	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif.
11534	Duncan Electronic, Inc.	Santa Ana, Calif.
11711	Gen'l Inst/Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.

Code No.	Manufacturer	Address
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Daven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tranac Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21226	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21335	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
22446	General Electric Co.	Schenectady, N.Y.
24455	G.E., Lamp Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
33434	Lectrahm, Inc.	Chicago, Ill.
36196	Stanwyck Corp.	Hawkesburn, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Muter Co.	Chicago, Illinois
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass.
52090	Rowan Controller Co.	Baltimore, Md.
53743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59730	Thomas and Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inc.	Bluffton, Ohio
61775	Union Switch and Signal, Div. Westinghouse Air Brake Co.	Swissvale, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	West Inst./Div. Daystrom	Newark, N.J.
66295	Wittek Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Alimeta Scientific Prod. Co, Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc.	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co.	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71785	A. O. Smith Corp. Crowley Div.	West Orange, N.J.
71984	Cinch Mfg. Corp.	Chicago, Illinois
72092	Dow Corning Corp.	Midland, Mich.
72136	Eitel-McCullough, Inc.	San Bruno, Calif.
72619	Electro Motive Mfg. Co, Inc.	Willimantic, Conn.
72699	Coto Coil, Co., Inc.	Providence, R.I.
72854	John E Fast and Company	Chicago, Illinois
72929	Dialight Corp.	Brooklyn, N.Y.
72965	General Ceramics Corp.	Keasbey, N.J.
72982	General Instrument Corp. Semiconductor Div.	Newark, N.J.
73061	Girard-Hopkins	Oakland, Calif.
73063	Drake Mfg. Co.	Chicago, Illinois
73076	Hugh H. Eby, Inc.	Philadelphia, Pa.
73138	Gudeman Co.	Chicago, Illinois
73293	Robert M. Hadley Co.	Los Angeles, Calif.
73445	Erie Resistor Corp.	Erie, Pa.
73490	Hansen Mfg. Co., Inc.	Princeton, Ind.
73506	H. M. Harper Co.	Chicago, Illinois
73559	Helipot, Div. Beckman Instruments, Inc.	Fullerton, Calif.
73682	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73734	Amperex Electronic Co., Div. No. American Phillips Co., Inc.	Hicksville, N.Y.
73743	Beckman Helipot Corp.	S. Pasadena, Calif.
73793	Bradley Semiconductor Corp.	Hamden, Conn.
73846	Carling Electric, Inc.	Hartford, Conn.
73899	George K. Garrett Co., Inc.	Philadelphia, Pa.
73905	Federal Screw Prod. Co.	Chicago, Illinois
74276	Fischer Special Mfg. Co.	Cincinnati, Ohio
74455	The General Industries Co.	Elyria, Ohio
74501	Goshen Stamping and Tool	Goshen, Ind.
74665	JFD Electronics Corp.	Brooklyn, N.Y.
74760	Jennings Radio Mfg. Co.	San Jose, Calif.
74861	Signalite, Inc.	Neptune, N.J.
74868	J. H. Winns and Sons	Winchester, Mass.
74870	Industrial Condenser Corp.	Chicago, Illinois
75042	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
75183	E.F. Johnson Co.	Waseca, Minn.
75278	International Resistance Co.	Philadelphia, Pa.
75382	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75395	James Knights Co.	Sandwich, Illinois
75487	Kulka Electric Corp.	Mt. Vernon, N.Y.
75570	Lenz Electric Mfg. Co.	Chicago, Illinois
75818	Littlefuse, Inc.	Des Plaines, Illinois
75915	Lord Mfg. Co.	Erie, Pa.
76005	C.W. Marwedel	San Francisco, Calif.
76210	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
76433	James Millen Mfg. Co., Inc.	Malden, Mass.
76487	J.W. Miller Co.	Los Angeles, Calif.
76493	Monadnock Mills	San Leandro, Calif.
76530	Mueller Electric Co.	Cleveland, Ohio
76545	Oak Manufacturing Co.	Crystal Lake, Illinois
76854	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77068	Pacific Metals Co.	San Francisco, Calif.
77071	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif.
77221	Phaostron Co.	Chicago, Illinois
77250	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77252	Potter and Brumfield, Div. of American Machine/Foundry	Princeton, Ind.
77342	Radio Condenser Co.	Camden, N.J.
77630	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77638	Resistance Products Co.	Harrisburg, Pa.
77764	Rubbercraft Corp. of Calif.	Torrance, Calif.
77969	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78189	Signal Indicator Corp.	New York, N.Y.
78283	Struthers-Dunn, Inc.	Pitman, N.J.
78290	Thompson-Bremer and Co.	Chicago, Illinois
78452	Tilley Manufacturing Co.	San Francisco, Calif.
78471	Stackpole Carbon Co.	St. Marys, Pa.
78488	Standard Thomson Corp.	Waltham, Mass.
78493	Tinnerman Products, Inc.	Cleveland, Ohio
78553	Transformer Engineers	Pasadena, Calif.
78790	Ucinite Co.	Newtonville, Mass.
78947	Veeder Root, Inc.	Hartford, Conn.
79142	Wanco Mfg. Co.	Chicago, Illinois
79251	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
79727	Zierick Mfg. Corp.	New Rochelle, N.Y.
79963	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80031	Schnitzer Alloy Products	Elizabeth, N.J.
80120	Times Facsimile Corp.	New York, N.Y.
80130	Electronic Industries Assoc. Any brand tube meeting EIA standards.	Washington D.C.
80131	Unimax Switch, Div. of W L Maxson Corp.	Wallingford, Conn.
80207	United Transformer Corp.	New York, N.Y.
80223	Oxford Electric Corp.	Chicago, Illinois
80248	Bourns Laboratories, Inc.	Riverside, Calif.
80294	Acro, Div. Robertshaw Fulton Controls Co.	Columbus, Ohio
80411	All Star Products, Inc.	Defiance, Ohio
80486	Avery Adhesive Label Corp.	Monrovia, Calif.
80509	Hammerlund Co., Inc.	New York, N.Y.
80583	Stevens, Arnold Co., Inc.	Boston, Mass.
80640	International Instruments, Inc.	New Haven, Conn.
81030	Graybill Co.	LaGrange, Illinois
81073	Triad Transformer Corp.	Venice, Calif.
81095	Winchester Electronics Co, Div.	Norwalk, Conn.
81312	Military Specifications	.....
81349	Wilkor Products, Inc.	Cleveland, Ohio
81415	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper.	Newton, Mass.
81453	International Rectifier Corp.	El Segundo, Calif.
81483	The Airpax Products Co.	Cambridge, Mass.
81541	Barry Controls, Inc.	Watertown, Mass.
81860	Carter Parts Co.	Skokie, Illinois
82042	Jeffers Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82142	Allen D. DuMont Labs, Inc.	Clifton, N.J.
82170	Maguire Industries, Inc.	Greenwich, Conn.
82209	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82219	Astron Company	E. Newark, N.J.
82376	Switchcraft, Inc.	Orange, Illinois
82389	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82647	Research Products Corp.	Madison, Wisc.
82866	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82877	Vector Electronic Co.	Glendale, Calif.
82893	Western Washer Mfr. Co.	Los Angeles, California
83053	Carr Fastener Co.	Cambridge, Mass.
83058	New Hampshire Ball Bearing	Peterborough, N.H.
83086	Pyramid Electric Co.	Darlington, S.C.
83125	Electro Cords Co.	Los Angeles, Calif.
83148	Victory Engineering Corp.	Springfield, N.J.
83186	Bendix Corp/Red Bank Div.	Red Bank, N.J.
83298	Hubbell Corp.	Mundelein, Illinois
83315	Smith, Herman H., Inc.	Brooklyn, N.Y.
83330	Central Screw Co.	Chicago, Illinois
83385	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass.
83501	Burroughs Corp., Electronic Tube Div.	Plainfield, N.J.
83594	Eveready Battery	New York, N.Y.
83740	Model Eng. and Mfg., Inc.	Huntington, Ind.
83777	Loyd Scruggs Co.	Festus, Mo.
83821	Arco Electronics, Inc.	New York, N.Y.
84171	A.J. Glesener Co., Inc.	San Francisco, Calif.
84396	Good All Electric Mfg. Co.	Ogallala, Neb.
84411	Sarkes Tarzian, Inc.	Bloomington, Ind.
84970	Boonton Molding Co.	Boonton, N.J.
85454	R.M. Bracamonte and Co.	San Francisco, Calif.
85474	Kaeled Kords, Inc.	New Haven, Conn.
85660	Seamless Rubber Co.	Chicago, Illinois
85911	Clifton Precision Products	Clifton Heights, Pa.
86197	Precision Rubber Products Corp.	Dayton, Ohio
86579	Radio Corp. of America, RCA Electron Tube Div.	Harrison, N.J.
86684	Philco Corp. (Lansing Div.)	Lansing, Pa.
87216	Western Fibrous Glass Products Co.	San Francisco
87473	Van Waters and Rogers, Inc.	Seattle, Wash.
87664	Tower Mfg. Co.	Providence, R.I.
87930	Cutler-Hammer, Inc.	Lincoln, Illinois
88140	Gould-National Batteries, Inc.	St. Paul, Minn.
88220	General Mills, Inc.	Buffalo, N.Y.
88698	Graybar Electric Co.	Oakland, Calif.
89231	Wales Kahinaar, Inc.	Cambridge, Mass.
89462	General Electric Distributing Corp.	Schenectady, N.Y.
89473	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89636	United Transformer Co.	Chicago, Illinois
89665	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90179	Bearing Engineering Co.	San Francisco, Calif.
90970	Connor Spring Mfg. Co.	San Francisco, Calif.
91260	Miller Dial and Nameplate Co.	El Monte, Calif.
91345	Radio Materials Co.	Chicago, Illinois
91418	Augat Brothers', Inc.	Attleboro, Mass.
91506	Dale Electronics, Inc.	Columbus, Nebr.
91637	Elco Corp.	Philadelphia
91662	Gremar Mfg Co., Inc.	Wakefield, Mass.
91737	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91929	Nahm-Bras. Spring Co.	Oakland, Calif.
91961	Tru-Connector Corp.	Peabody, Mass.
92180	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92196	Elgeet Optical Co., Inc.	Rochester, N.Y.
92367	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
92607	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass.
93333	Robbins and Myers, Inc.	New York, N.Y.
93369	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93410	Howard J. Smith, Inc.	Port Monmouth, N.J.
93788	G.V. Controls	Livingston, N.J.
93929	Insuline-Van Norman Ind., Inc. Electronic Division	Manchester, N.H.
93983	General Cable Corp.	Bayonne, N.J.
94137	Raytheon Mfg. Co., Industrial Comp. Div. Rec. Tube Div.	Quincy, Mass.
94144	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94145	Scientific Radio Products	Loveland, Colo.
94148	Tung-Sol Electric, Inc.	Newark, N.J.
94154	Curtiss-Wright Corp. Electronics Div.	E. Paterson, N.J.
94197	Southco, Div. S. Chester Corp.	Lester, Pa.
94302	Tru Ohm Prod., Div. Model Engineering and Mfg. Co.	Chicago, Illinois
94310	Wire Cloth Products, Inc.	Chicago, Illinois
94330	Worcester Pressed Alum. Corp.	Worcester, Mass.
94682	Philbrick Researchers, Inc.	Boston, Mass.
95026	Allies Products Corp.	Miami, Fla.
95236	Continental Connector Corp.	Woodside, N.Y.
95238	Lowcraft Mfg. Co., Inc.	New York, N.Y.
95253	Lerco Electronics, Inc.	Burbank, Calif.
95264	National Coil Co.	Sheridan, Wyo.
95265	Vitramon, Inc.	Bridgeport, Conn.
95275	Gordos Corp.	Bloomfield, N.J.
95348	Methode Mfg. Co.	Chicago, Illinois
95354	Dage Electric Co., Inc.	Franklin, Ind.
95712	Weckesser Co.	Chicago, Illinois
95987	Huggins Laboratories	Sunnyvale, Calif.
96067	Hi-Q Div. of Aerovox	Olean, N.Y.
96095	Thordarson-Meissner Div. Maguire Industries, Inc.	Mt. Carmel, Ill.
96256	Solar Manufacturing Co.	Los Angeles, Calif.
96296	Carlton Screw Co.	Chicago, Illinois
96330	Microwave Associates, Inc.	Burlington, Mass.
96341	Excel Transformer Co.	Oakland, Calif.
96501	Industrial Retaining Ring Co.	Irvington, N.J.
97464	Automatic and Precision Mfg.	Yonkers, N.Y.
97539	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97966	Reon Resistor Corp.	Yonkers, N.Y.
97979	Axel Brothers, Inc.	Jamaica, N.Y.
98141	Rubber Teck, Inc.	Gardena, Calif.
98159	Francis L. Mosley	Pasadena, Calif.
98220	Microdot, Inc.	S. Pasadena, Calif.
98278	Seelectro Corp.	Mamaroneck, N.Y.
98291	Conrad Corp.	Rockwood City, Calif.
98405	General Mills	Minneapolis, Minn.
98731	North Hills Electric Co.	Mineola, N.Y.
98821	Clevite Transistor Prod. Div. Clevite Corp.	Waltham, Mass.
98925	International Electronic Research Corp.	Burbank, Calif.
98978	Columbia Technical Corp.	New York, N.Y.
99109	Varian Associates	Palo Alto, Calif.
99313	Marshall Industries, Electron Products Division	Pasadena, Calif.
99515	Control Switch Div, Controls Co. of America	El Segundo, Calif
99707	Delevan Electronics Corp.	E. Aurora, N.Y.
99800	Wilco Corporation	Indianapolis, Ind.
99848	Renbrandt, Inc.	Boston, Mass.
99934	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99942	Technology Instrument Corp. of California	Newbury Park, Calif.
99957		

PART	DESCRIPTION	EXACT NO	MFG
B001	PILOT LIGHT	1360045.	71744.
C001	CAPACITOR, 2000MFD 25V	2900032.	14655.
C002	CAPACITOR, 2000MFD 25V	2900032.	14655.
C003	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C010	CAPACITOR, 470FF MICA	2810539.	853.
C013	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C040	CAPACITOR, 5000 PF DISC	2830011.	91418.
C041	CAPACITOR, 220PF MICA	2810555.	853.
C042	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C043	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C060	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
C061	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C100	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
C101	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C102	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
C103	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C121	CAPACITOR, 150PF MICA	2810557.	853.
C150	CAPACITOR, 8PF MICA	2810535.	853.
C170	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C190	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C200	CAPACITOR, 470PF MICA	2810539.	853.
C205	CAPACITOR, 22PF MICA	2810530.	853.
C210	CAPACITOR, 3-12PF TRIM	2810036.	72982.
C230	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
C231	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C250	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
C251	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C253	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C260	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C270	CAPACITOR, 390PF MICA	2810556.	853.
C320	CAPACITOR, 5000 PF DISC	2830011.	91418.
C321	CAPACITOR, 220PF MICA	2810555.	853.
C322	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C323	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C330	CAPACITOR, 5000 PF DISC	2830011.	91418.
C331	CAPACITOR, 220PF MICA	2810555.	853.
C332	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C333	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C334	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
C360	CAPACITOR, 5000 PF DISC	2830011.	91418.
C361	CAPACITOR, 220PF MICA	2810555.	853.
C362	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C380	CAPACITOR, 220PF MICA	2810555.	853.
C381	CAPACITOR, 5000 PF DISC	2830011.	91418.
C382	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C401	CAPACITOR, TIMING SET	2950004.	10597.
C403	CAPACITOR, 150PF MICA	2810557.	853.
C404	CAPACITOR, 8-50PF TRIM	2810022.	72982.
C405	CAPACITOR, SELECTED VALUE		
C406	CAPACITOR, 8PF MICA	2810535.	853.
C430	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C431	CAPACITOR, 47PF MICA	2810532.	853.
C432	CAPACITOR, 8-50PF TRIM	2810022.	72982.
C433	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C434	CAPACITOR, 6.8 MFD 35 VOLT	2900043.	100002.
C491	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C500	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C531	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C540	CAPACITOR, 0.05 UF DISC	2830010.	91418.
C550	CAPACITOR, 0.05 UF DISC	2830010.	91418.
D001	RECTIFIER BRIDGE, MDA920A-3	1520920.	4713.
D050	DIODE, 1N756	1520756.	1295.
D100	DIODES, MATCHED SET FD777	1530777.	10597.
D104	DIODES, MATCHED SET FD777	1530777.	10597.
D108	DIODES, MATCHED SET FD777	1530777.	10597.
D170	DIODE, 1N914	1520914.	7910.
D180	DIODE, 1N914	1520914.	7910.
D250	DIODE, 1N914	1520914.	7910.
D260	DIODE, 1N914	1520914.	7910.
D370	DIODES, MATCHED SET FD777	1530777.	10597.
D451	DIODE, 1N914	1520914.	7910.
D452	DIODE, 1N914	1520914.	7910.
D460	DIODE, 1N914	1520914.	7910.
D461	DIODE, 1N914	1520914.	7910.
D462	DIODE, 1N914	1520914.	7910.
D463	DIODE, 1N914	1520914.	7910.
D470	DIODE, 1N914	1520914.	7910.
D530	DIODE, 1N914	1520914.	7910.
D531	DIODE, 1N914	1520914.	7910.
D532	DIODE, 1N914	1520914.	7910.
D540	DIODE, 1N914	1520914.	7910.
D541	DIODE, 1N914	1520914.	7910.
D542	DIODE, 1N914	1520914.	7910.
D550	DIODE, 1N914	1520914.	7910.
D551	DIODE, 1N914	1520914.	7910.
D552	DIODE, 1N914	1520914.	7910.
D553	DIODE, 1N914	1520914.	7910.
F001	FUSE, 3AG 1/4 AMP SLO-BLO	1590025.	71400.
Q010	INTEGRATED CIRCUIT, UA723	1580012.	7263.
Q020	TRANSISTOR, 2N4921	1564921.	4713.
Q040	OPERATIONAL AMPLIFIER, UA709	1580016.	7263.
Q050	TRANSISTOR, 2N3638	1563638.	7263.
Q060	TRANSISTOR, 2N4918	1564918.	4713.
Q065	TRANSISTOR, 2N3643	1563643.	4713.
Q120	TRANSISTORS, MATCHED PAIR MPS36	1570008.	10597.
Q140	TRANSISTOR, MPS3646	1563646.	4713.
Q150	TRANSISTOR, MATCHED 2N4121	1574121.	10597.
Q170	TRANSISTOR, MPS3646	1563646.	4713.
Q180	TRANSISTOR, MPS3646	1563646.	4713.
Q190	TRANSISTOR, 2N4121	1564121.	7263.
Q200	TRANSISTORS, MATCHED PAIR MPS36	1570008.	10597.
Q220	TRANSISTOR, MPS3646	1563646.	4713.
Q230	TRANSISTOR, 2N2905	1562905.	1295.
Q240	TRANSISTOR, 2N2905	1562905.	1295.
Q250	TRANSISTOR, 2N2219	1562219.	1295.
Q260	TRANSISTOR, 2N2905	1562905.	1295.
Q320	OPERATIONAL AMPLIFIER, UA709	1580016.	7263.
Q330	OPERATIONAL AMPLIFIER, UA709	1580016.	7263.
Q340	TRANSISTOR, SELECTED 2N5462	1575462.	10597.
Q350	TRANSISTOR, TD101	1580017.	56289.
Q360	OPERATIONAL AMPLIFIER, UA709	1580016.	7263.
Q370	TRANSISTOR, 2N5462	1565462.	4713.

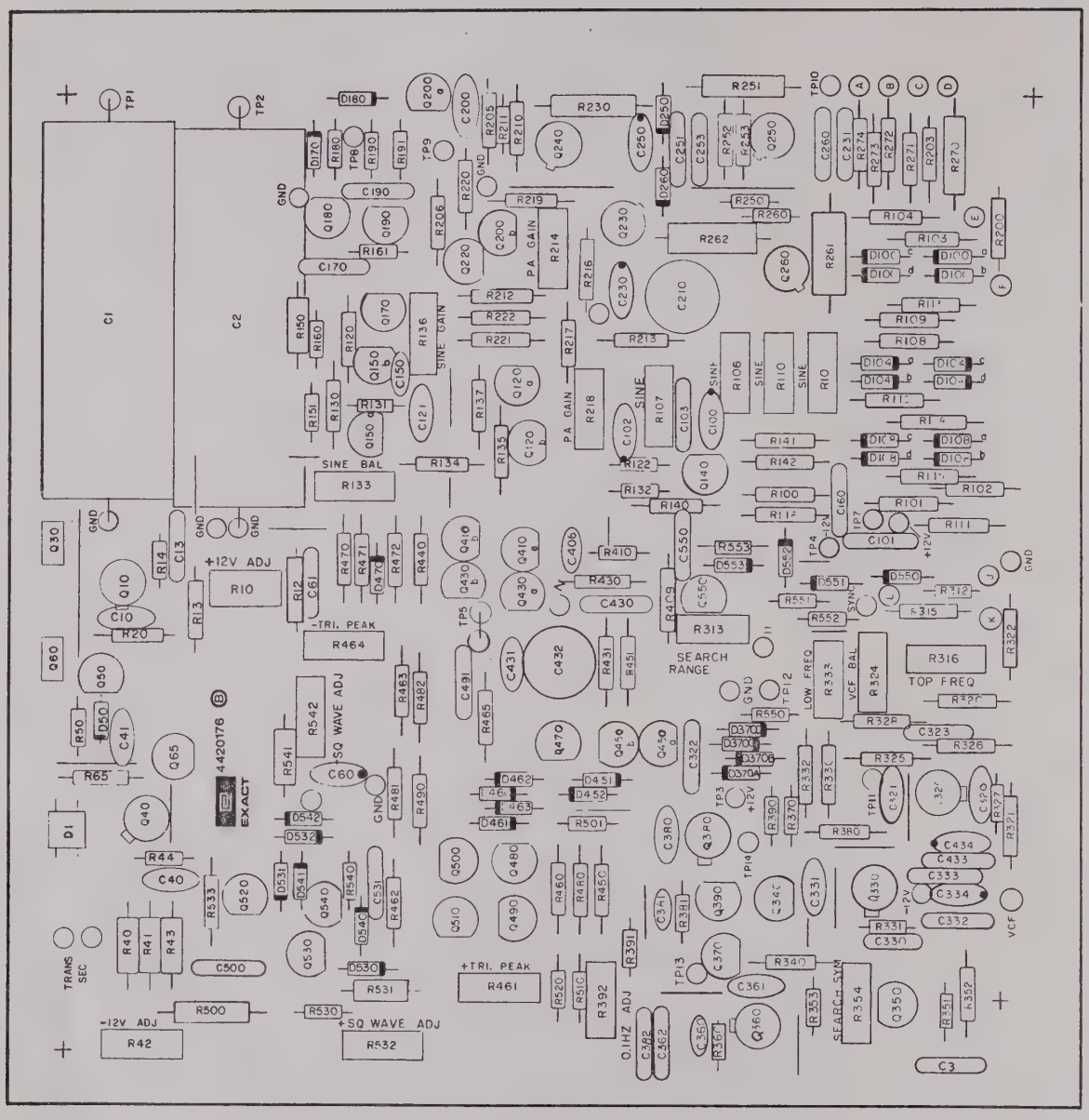
PART	DESCRIPTION	EXACT NO	MFG
Q380	OPERATIONAL AMPLIFIER, UA709	1580016.	7263.
Q390	TRANSISTOR, 2N5485	1565485.	4713.
Q410	TRANSISTORS, MATCHED 2N5485	1575485.	10597.
Q430	TRANSISTORS, MATCHED PAIR MPS36	1570008.	10597.
Q450	TRANSISTORS, MATCHED PAIR MPS36	1570008.	10597.
Q470	TRANSISTOR, MPS3646	1563646.	4713.
Q480	TRANSISTOR, MPS3640	1563640.	4713.
Q490	TRANSISTOR, MPS3640	1563640.	4713.
Q500	TRANSISTOR, MPS3640	1563640.	4713.
Q510	TRANSISTOR, MPS3640	1563640.	4713.
Q520	TRANSISTOR, 2N3638	1563638.	7263.
Q530	TRANSISTOR, MPS3646	1563646.	4713.
Q540	TRANSISTOR, MPS3640	1563640.	4713.
Q550	TRANSISTOR, 2N4121	1564121.	7263.
R001	RESISTOR, 68K OHM 1/4W 5% CARBON	3070683.	1121.
R010	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R012	RESISTOR, 3240 OHM 1/4W 1% METAL FILM	3133241.	7115.
R013	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001.	7115.
R014	RESISTOR, 1200 OHM 1/4W 5% CARBON	3070122.	1121.
R020	RESISTOR, 2.0 OHM 1/2W 5% CARBON	3010020.	1121.
R040	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
R041	RESISTOR, 9760 OHM 1/4W 1% METAL FILM	3139761.	7115.
R042	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R043	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
R044	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
R050	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
R065	RESISTOR, 1.0 OHM 1/2W 5% CARBON	3010010.	1121.
R100	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990.	7115.
R101	RESISTOR, 54.9 OHM 1/4W 1% METAL FILM	3130549.	7115.
R102	RESISTOR, 150 OHM 1/4W 1% METAL FILM	3131500.	7115.
R103	RESISTOR, 8450 OHM 1/4W 1% METAL FILM	3138451.	7115.
R104	RESISTOR, 8450 OHM 1/4W 1% METAL FILM	3138451.	7115.
R105	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R106	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R107	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R108	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531.	7115.
R109	RESISTOR, 9530 OHM 1/4W 1% METAL FILM	3139531.	7115.
R110	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R111	RESISTOR,19100 OHM 1/4W 1% METAL FILM	3131912.	7115.
R112	RESISTOR,19100 OHM 1/4W 1% METAL FILM	3131912.	7115.
R113	RESISTOR, 309 OHM 1/4W 1% METAL FILM	3133090.	7115.
R114	RESISTOR, 200 OHM 1/8W 1% METAL FILM	3182000.	7115.
R115	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131270.	7115.
R116	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3130499.	7115.
R120	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211.	7115.
R122	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
R130	RESISTOR, 1210 OHM 1/4W 1% METAL FILM	3131211.	7115.
R131	RESISTOR, 20 OHM 1/4W 5% CARBON	3070200.	1121.
R132	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
R133	POTENTIOMETER, 100K OHM TRIM	3110143.	71450.
R134	RESISTOR, 33.2K OHM 1/4W 1% METAL FILM	3133322.	7115.
R135	RESISTOR, 63.4 OHM 1/4W 1% METAL FILM	3130634.	7115.
R136	POTENTIOMETER, 100 OHM TRIM	3110141.	71450.
R137	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420.	7115.
R140	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
R141	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
R142	RESISTOR, 681 OHM 1/4W 1% METAL FILM	3136810.	7115.
R150	RESISTOR, 330 OHM 1/2W 5% CARBON	3010331.	1121.
R151	RESISTOR, 39 OHM 1/4W 5% CARBON	3070390.	1121.
R160	RESISTOR, 39 OHM 1/4W 5% CARBON	3070390.	1121.
R161	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
R180	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
R190	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
R191	RESISTOR, 3000 OHM 1/4W 5% CARBON	3070302.	1121.
R200	RESISTOR, 110 OHM 1/4W 1% METAL FILM	3131100.	7115.
R201	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3070047.	1121.
R202	CONCENTRIC SWITCH AND POTENTIOM	2600311.	71450.
R203	RESISTOR, 4.7 OHM 1/2W 5% CARBON	3010047.	1121.
R205	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001.	7115.
R206	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000.	7115.
R210	RESISTOR, 2000 OHM 1/4W 1% METAL FILM	3132001.	7115.
R211	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
R212	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000.	7115.
R213	RESISTOR, 976 OHM 1/4W 1% METAL FILM	3139760.	7115.
R214	POTENTIOMETER, 100 OHM TRIM	3110141.	71450.
R215	RESISTOR, 75.0 OHM 1/4W 1% METAL FILM	3130750.	7115.
R216	RESISTOR, 1100 OHM 1/4W 1% METAL FILM	3131101.	7115.
R217	RESISTOR, 33.2K OHM 1/4W 1% METAL FILM	3133322.	7115.
R218	POTENTIOMETER, 100K OHM TRIM	3110143.	71450.
R219	POTENTIOMETER, 10K OHM WITH SWI	3110333.	71450.
R220	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
R221	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
R222	RESISTOR, 1500 OHM 1/4W 1% METAL FILM	3131501.	7115.
R230	RESISTOR, 143 OHM 1/2W 1% METAL FILM	3101430.	7115.
R250	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
R251	RESISTOR, 68 OHM 1W 5% CARBON	3030680.	1121.
R252	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000.	7115.
R253	RESISTOR, 100 OHM 1/4W 1% METAL FILM	3131000.	7115.
R260	RESISTOR, 10 OHM 1/4W 5% CARBON	3070100.	1121.
R261	RESISTOR, 68 OHM 1W 5% CARBON	3030680.	1121.
R262	RESISTOR, 1500 OHM 1W 5% CARBON	3030152.	1121.
R270	RESISTOR, 453 OHM 1/2W 1% METAL FILM	3104530.	7115.
R271	RESISTOR, 56.2 OHM 1/4W 1% METAL FILM	3130562.	7115.
R272	RESISTOR, 41.2 OHM 1/8W 1% METAL FILM	3180412.	7115.
R273	RESISTOR, 41.2 OHM 1/8W 1% METAL FILM	3180412.	7115.
R274	RESISTOR, 10.0 OHM 1/8W 1% METAL FILM	3180100.	7115.
R300	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R301	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R302	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R303	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R304	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R305	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R306	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R307	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R308	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R309	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R310	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R311	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R312	RESISTOR, 332 OHM 1/4W 1% METAL FILM	3133320.	7115.
R313	POTENTIOMETER, 100 OHM TRIM	3110141.	71450.
R314	RESISTOR, 100 OHM 1/8W 1% METAL FILM	3181000.	7115.
R315	RESISTOR, 1300 OHM 1/4W 1% METAL FILM	3131301.	7115.

PART	DESCRIPTION	EXACT NO	MFG
R316	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R318	RESISTOR, SELECTED VALU		
R319	CONCENTRIC SWITCH & POTENTIOMET	2600313.	71450.
R320	RESISTOR,24900 OHM 1/4W 1% METAL FILM	3132492.	7115.
R321	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003.	7115.
R322	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003.	7115.
R324	POTENTIOMETER, 100K OHM TRIM	3110143.	71450.
R325	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003.	7115.
R326	RESISTOR, 4990 OHM 1/4W 1% METAL FILM	3134991.	7115.
R327	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
R328	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003.	7115.
R330	RESISTOR, 499 OHM 1/4W 1% METAL FILM	3134990.	7115.
R331	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
R332	RESISTOR, 100K OHM 1/4W 1% METAL FILM	3131003.	7115.
R333	POTENTIOMETER, 100K OHM TRIM	3110143.	71450.
R340	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138060.	7115.
R351	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
R352	RESISTOR, 806 OHM MATCHED PAIR	3128060.	10597.
R353	RESISTOR, 2700K OHM 1/4W 5% CARBON	3070275.	1121.
R354	POTENTIOMETER, 100K OHM TRIM	3110143.	71450.
R360	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
R370	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
R381	RESISTOR, 1500 OHM 1/4W 5% CARBON	3070152.	1121.
R390	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
R391	RESISTOR,10000K OHM 1/4W 5% CARBON	3070106.	1121.
R392	POTENTIOMETER, 100K OHM TRIM	3110143.	71450.
R401	RESISTOR, 80.6K OHM MATCHED PAIR	3128062.	10597.
R402	RESISTOR, 8060 OHM MATCHED PAIR	3128061.	10597.
R403	RESISTOR, 806 OHM MATCHED PAIR	3128060.	10597.
R409	RESISTOR, 442 OHM 1/4W 1% METAL FILM	3134420.	7115.
R410	RESISTOR, 51 OHM 1/4W 5% CARBON	3070510.	1121.
R430	RESISTOR, 160 OHM 1/2W 5% CARBON	3010161.	1121.
R431	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020.	7115.
R440	RESISTOR, 383 OHM 1/4W 1% METAL FILM	3133830.	7115.
R450	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221.	7115.
R451	RESISTOR, 402 OHM 1/4W 1% METAL FILM	3134020.	7115.
R460	RESISTOR, 4220 OHM 1/4W 1% METAL FILM	3134221.	7115.
R461	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R462	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531.	7115.
R463	RESISTOR, 4530 OHM 1/4W 1% METAL FILM	3134531.	7115.
R464	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R465	RESISTOR, 274 OHM 1/4W 1% METAL FILM	3132740.	7115.
R470	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211.	7115.
R471	RESISTOR,10000 OHM 1/4W 1% METAL FILM	3131002.	7115.
R472	RESISTOR, 3010 OHM 1/4W 1% METAL FILM	3133011.	7115.
R480	RESISTOR, 576 OHM 1/4W 1% METAL FILM	3135760.	7115.
R481	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750.	7115.
R482	RESISTOR, 715 OHM 1/4W 1% METAL FILM	3137150.	7115.
R490	RESISTOR, 475 OHM 1/4W 1% METAL FILM	3134750.	7115.
R500	RESISTOR, 120 OHM 1W 5% CARBON	3030121.	1121.
R501	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
R510	RESISTOR, 2400 OHM 1/4W 5% CARBON	3070242.	1121.
R520	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
R530	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
R531	RESISTOR, 160 OHM 1/2W 5% CARBON	3010161.	1121.
R532	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R533	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500.	7115.
R540	RESISTOR, 5100 OHM 1/4W 5% CARBON	3070512.	1121.
R541	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137500.	7115.
R542	POTENTIOMETER, 500 OHM TRIM	3110142.	71450.
R550	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
R551	RESISTOR, 4700 OHM 1/4W 5% CARBON	3070472.	1121.
R552	RESISTOR, 100 OHM 1/4W 5% CARBON	3070101.	1121.
R553	RESISTOR, 1000 OHM 1/4W 5% CARBON	3070102.	1121.
S001	SWITCH, TOGGLE SPDT	2600103.	100005.
S100	CONCENTRIC SWITCH AND POTENTIOM	2600311.	71450.
S200	SWITCH, MIN. ROTARY 3P3T	2600090.	76854.
S300	CONCENTRIC SWITCH & POTENTIOMET	2600313.	71450.
S400	SWITCH, ROTARY 5P8T	2600312.	71450.
T001	TRANSFORMER, POWER	1200036.	10597.

SECTION 7

SCHEMATICS

Figure 7.1.1	Deleted
Figure 7.1.2	Model 123 Parts Layout
Figure 7.2.1	Generator Loop
Figure 7.2.2	Signal Shaping and Amplifying Circuits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TP2
C1
C2
GND
+12V ADJ
R10
-TRI. PEAK
R464
SQ WAVE ADJ
R542
4420176 B
EXACT
SINE BAL
R133
SINE GAIN
R136
PA GAIN
R214
SINE
R107
SEARCH RANGE
R313
LOW FREQ
R333
VCF BAL
R324
TOP FREQ
R316
-12V ADJ
R42
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R461
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R354
TRANS SEC
VCF

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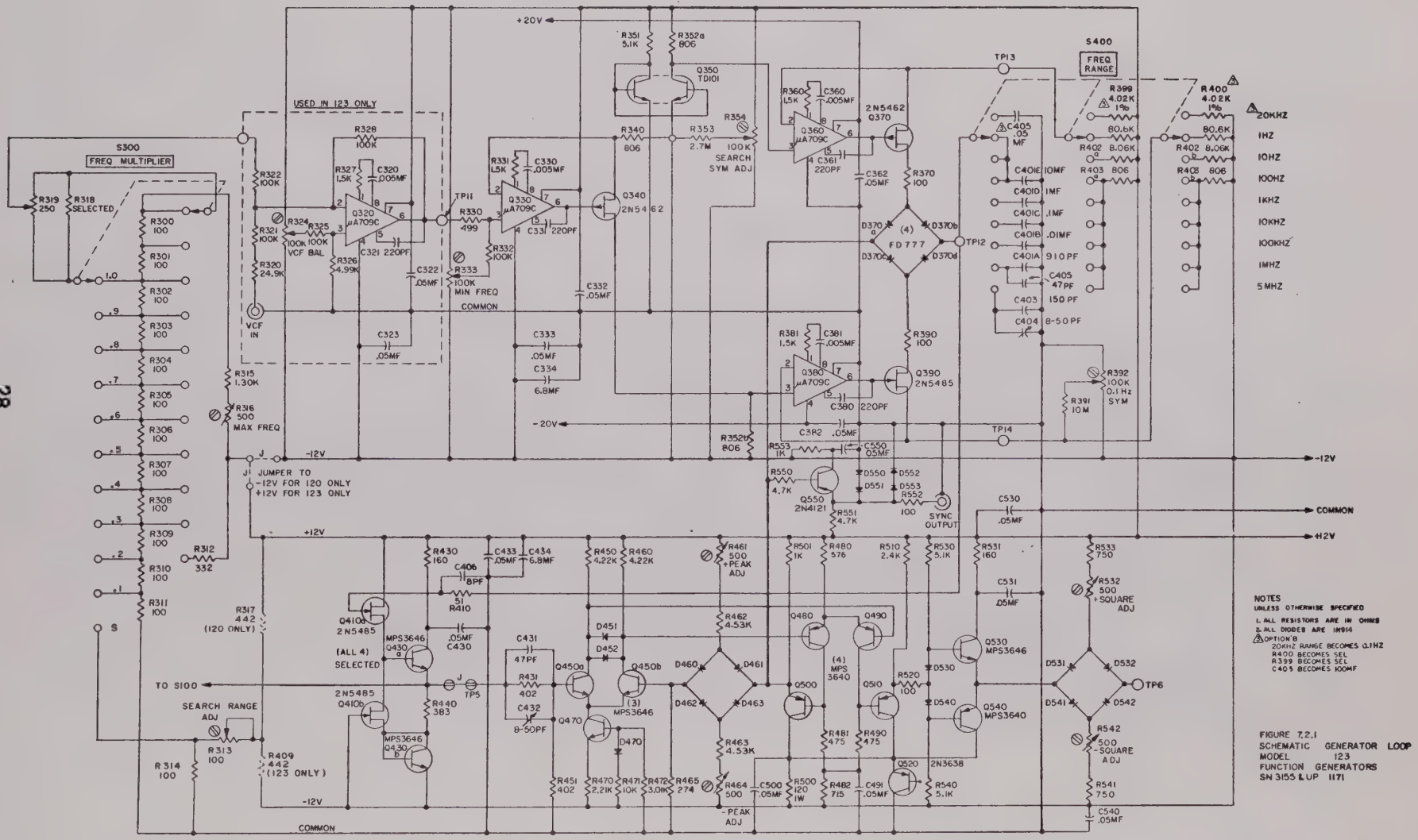
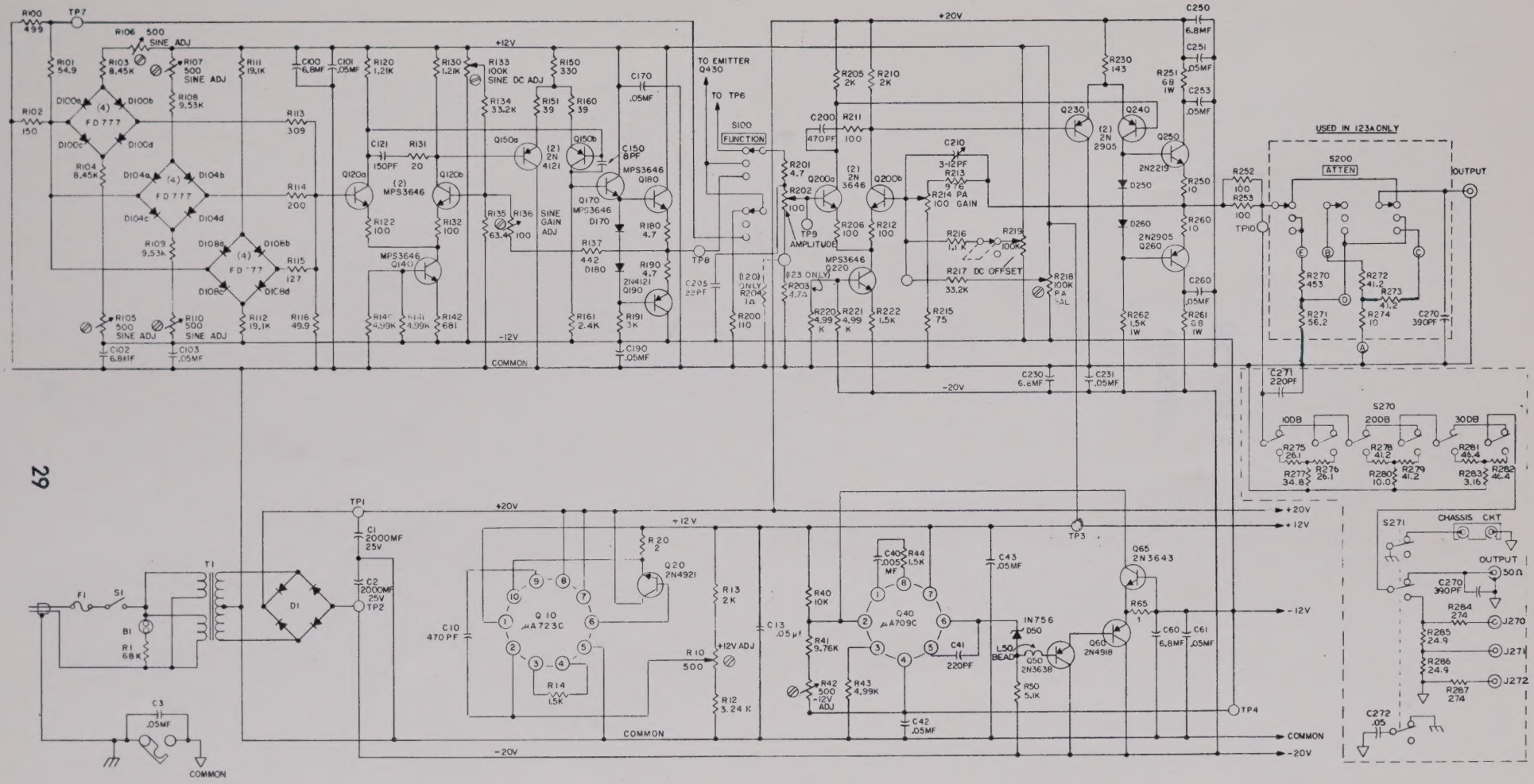


FIGURE 7.2.1
SCHEMATIC GENERATOR LOOP
MODEL 123
FUNCTION GENERATORS
SN 3155 & UP 1171



NOTES
UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS
2. ALL DIODES ARE IN914

FIGURE 7.2.2
SCHEMATIC, SIGNAL SHAPING & AMPLIFYING CIRCUITS
MODELS 123 FUNCTION GENERATORS
SN 3155 & UP 772
R&V ⓓ

SECTION 8

ADDENDA